NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSC INTERNAL NOTE NO. 66-FM-126

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A PARAMETRIC STUDY OF CENTRAL ANGLE OF TRAVEL AND TIME FOR REENTRY FROM NEAR-EARTH CIRCULAR ORBITS

By William R. Pruett
Flight Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION
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Approved: Charlie C. Allen for
Claiborne R. Hicks, Jr., Chief
Flight Analysis Branch

Approved:
John P. Mayer, Chief
Mission Planning and Analysis Division

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(f)	Retrograde pitch angle, β, = 50°	8
(g)	Retrograde pitch angle, β, = 60°	9
(h)	Retrograde pitch angle, β, = 70°	10

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SUMMARY AND INTRODUCTION

This study is a continuation of the circular orbit portion of reference 1, "General Parametric Study for Near-Earth Orbits," by Frank J. Suler. Contained in this report are the orbit-referenced central angle of travel from retrofire to 400 000 ft and the time from retrofire to 400 000 ft as functions of circular orbit altitude. The same ranges of retrograde pitch angles, retrograde ΔV's and circular orbits are used in this report as were used in reference 1. Since reference 1 presents reentry velocity and flight-path angle at 400 000 ft, this document and reference 1 should be used together to obtain a more valuable picture of reentry conditions.

For information concerning near-earth elliptic orbits, see reference 2.

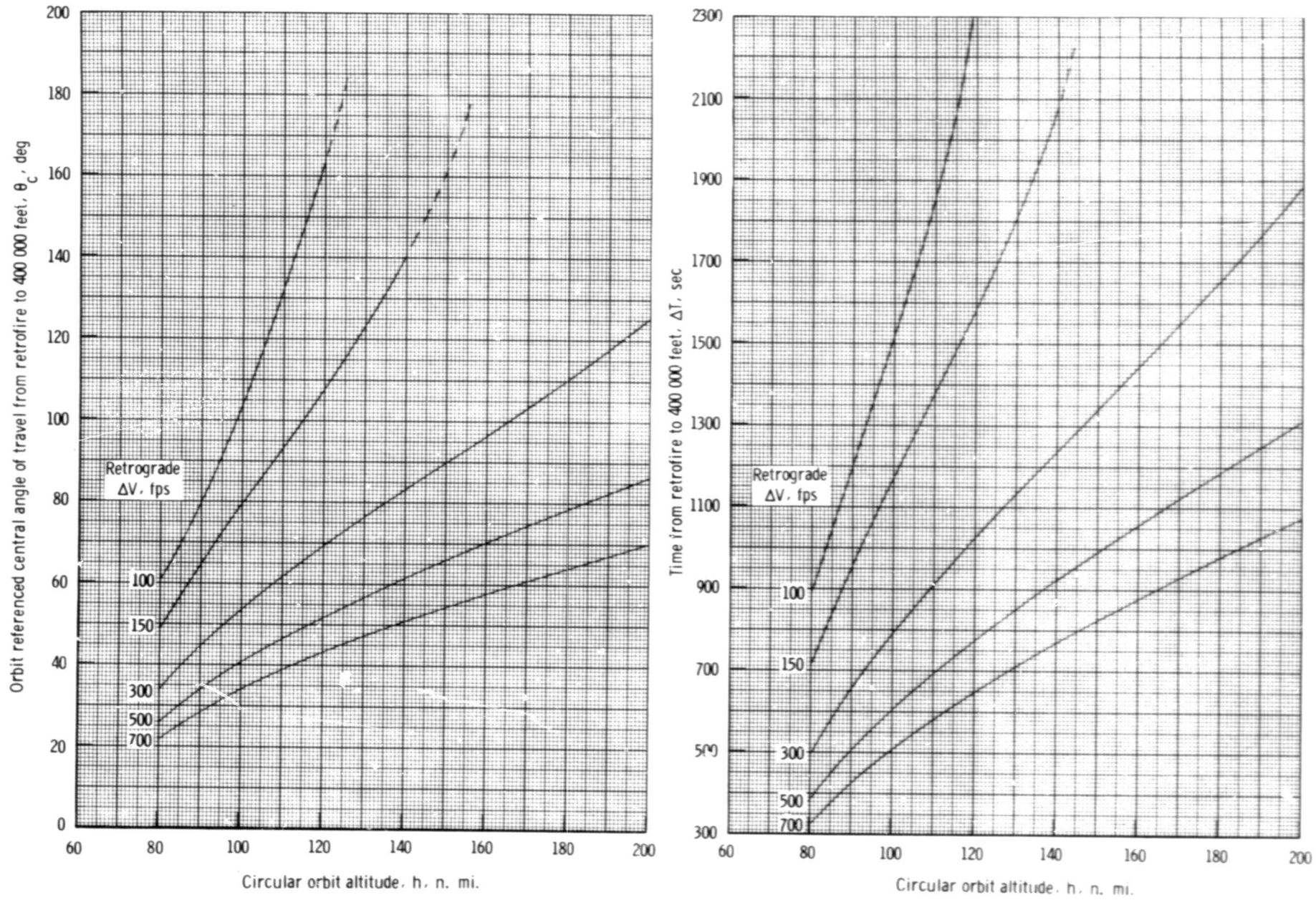
MATHEMATICAL MODEL

Keplerian equations, a spherical rotating earth, and instantaneous velocity changes were used in this study. The solutions were obtained from the general elliptical orbit and reentry program E042. Beta angles are measured positive clockwise from the local horizontal. For a geometric representation of the orbit parameters, see paragraph 2.2 of reference 1.

DISCUSSION OF RESULTS

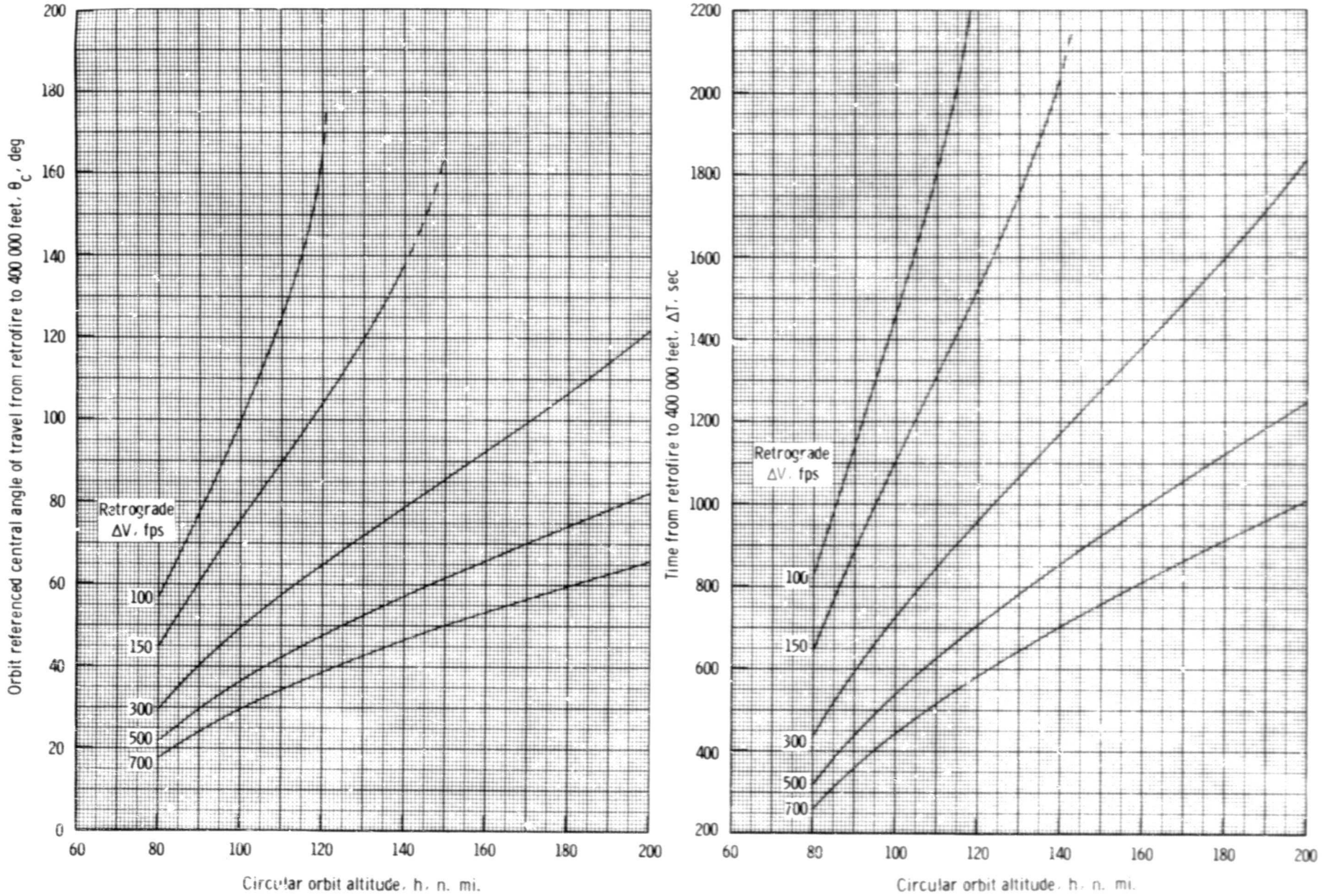
The figures present both time from retrofire to 400 000 ft and orbit-referenced central angle of travel from retrofire to 400 000 ft as functions of circular orbit altitude. Pitch angles of 0°, 10°, 20°, 30°, 40°, 50°, 60°, and 70° were used, and retrograde ΔV's of 100 fps,

150 fps, 300 fps, 500 fps and 700 fps were used for each plot. Dashed lines indicate extrapolated data, and reentrys under these conditions may be possible, although they are very near to and may result in a skip out at 400 000 ft.



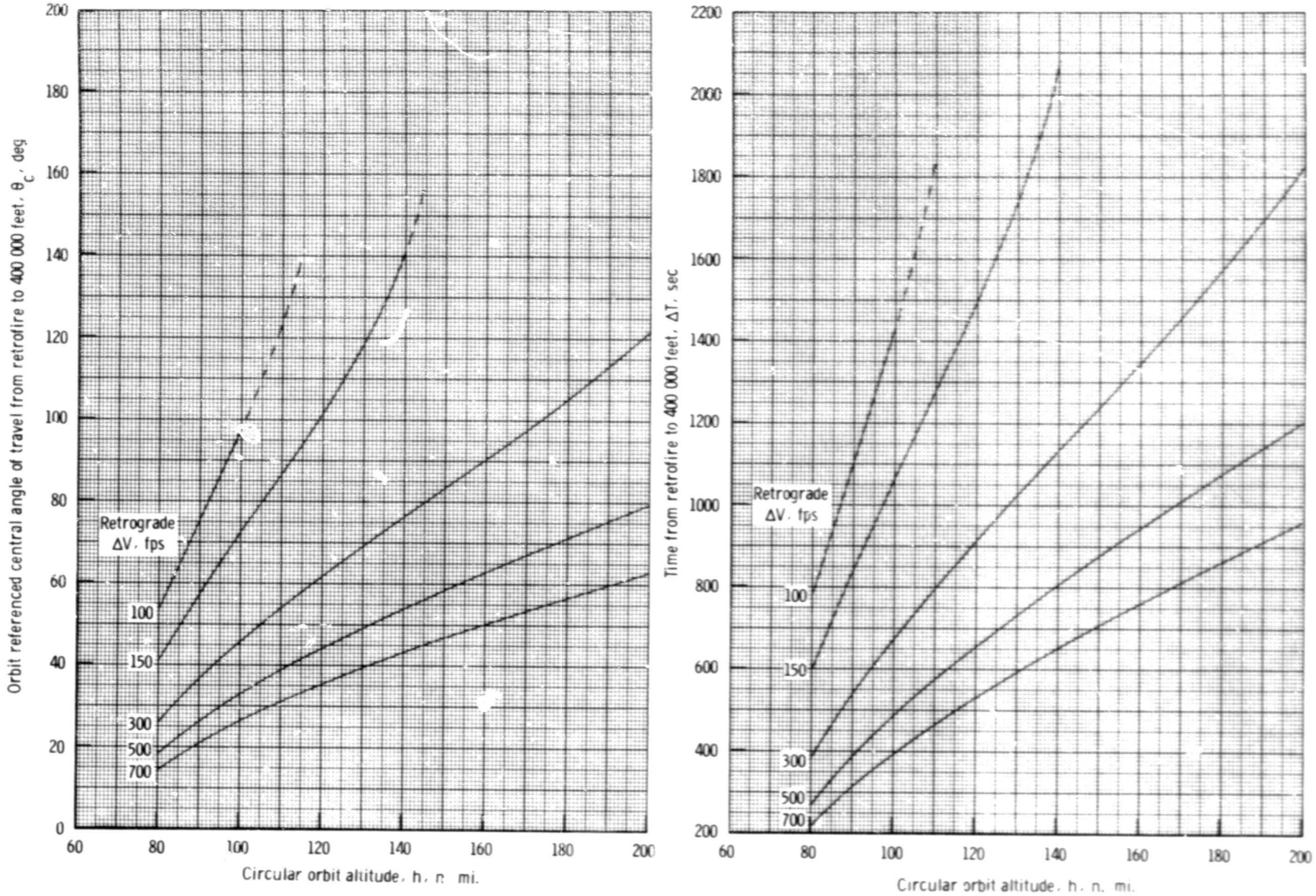
(a) Retrograde pitch angle $\beta = 0°$

Figure 1. - Orbit referenced central angle of travel and time from retrofire to 400 000 feet versus circular orbit altitude as a function of various retrograde ΔV's for several pitch angles.



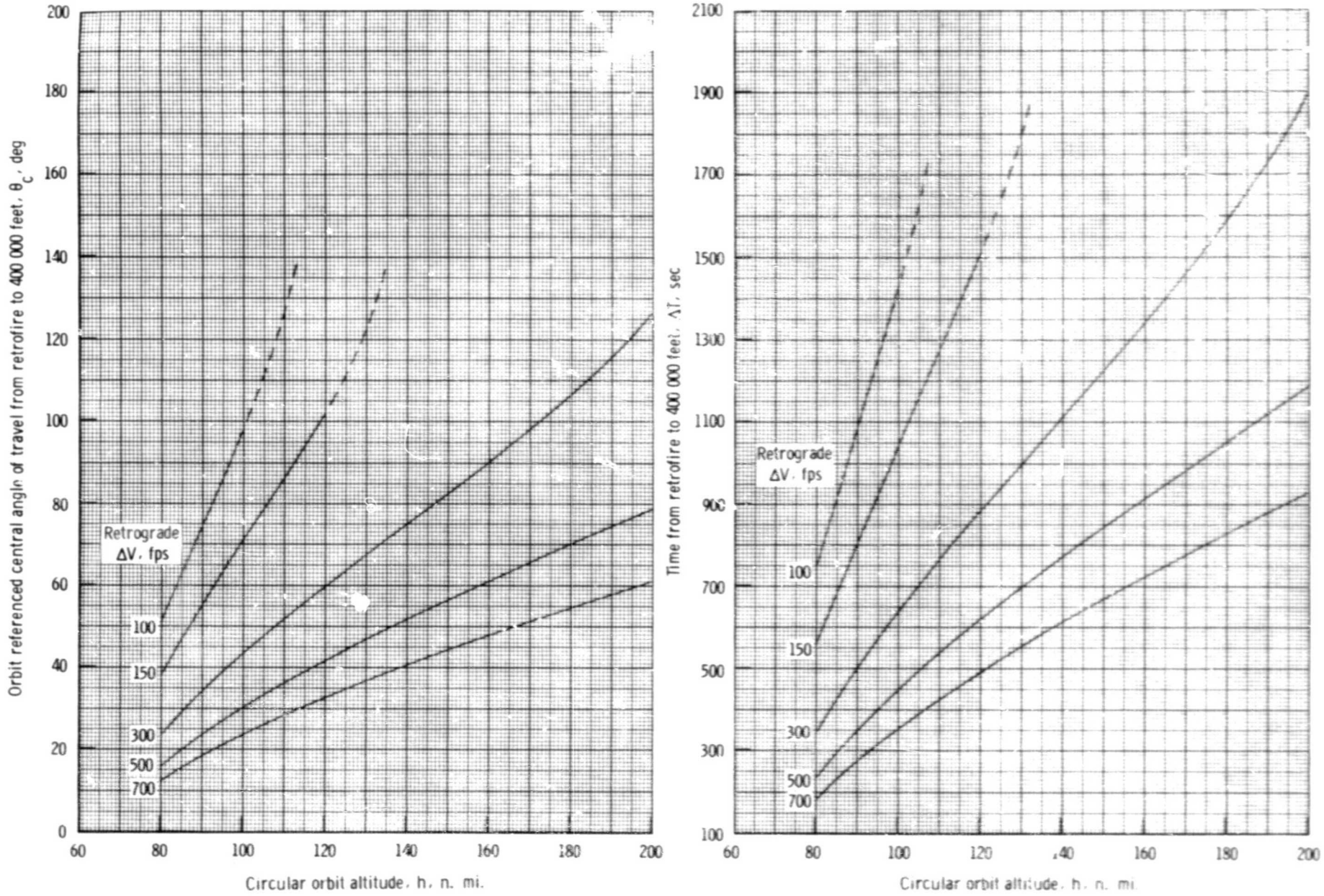
(b) Retrograde pitch angle $\beta = 10°$

Figure 1. - Continued



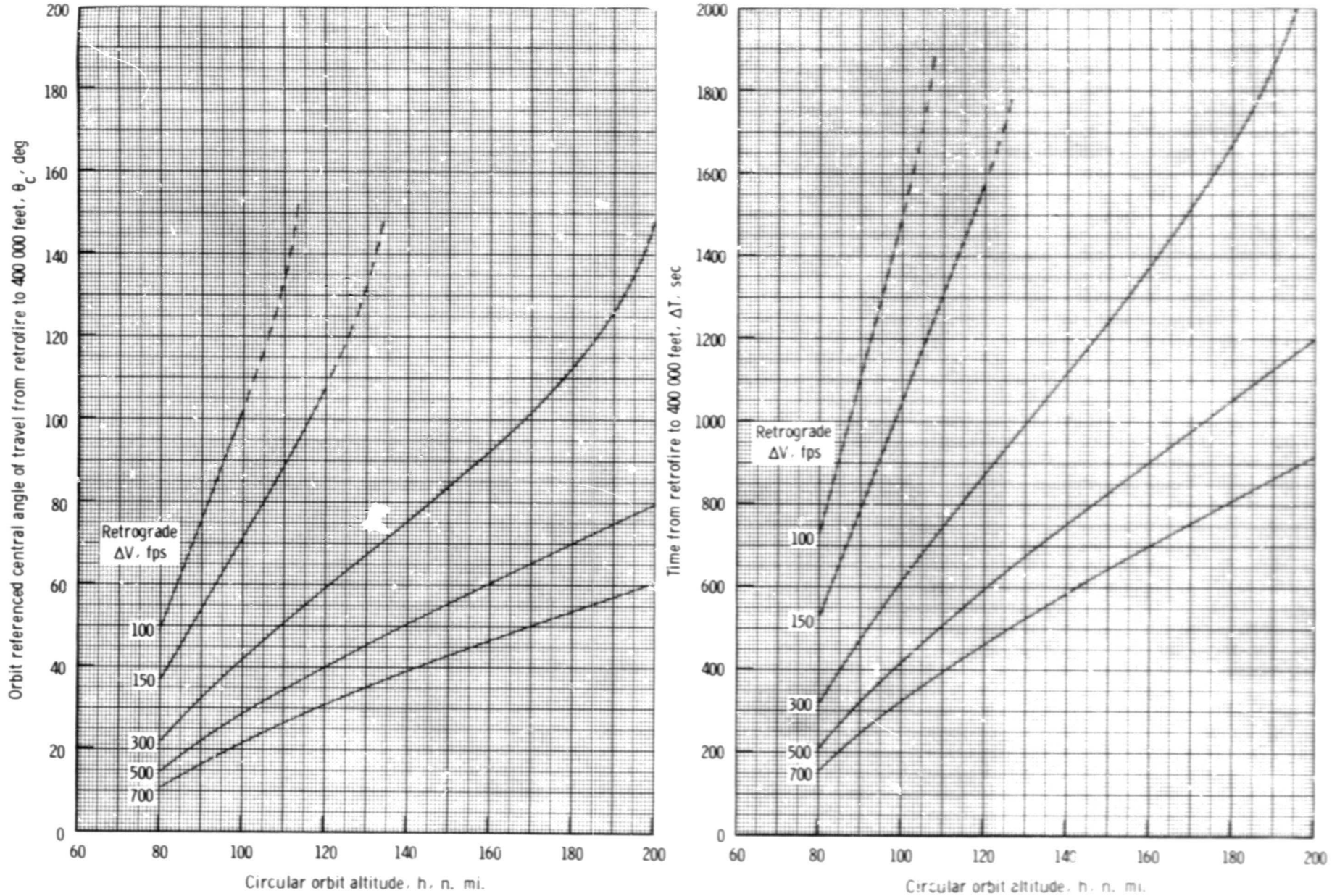
(c) Retrograde pitch angle $\beta = 20°$

Figure 1. - Continued.



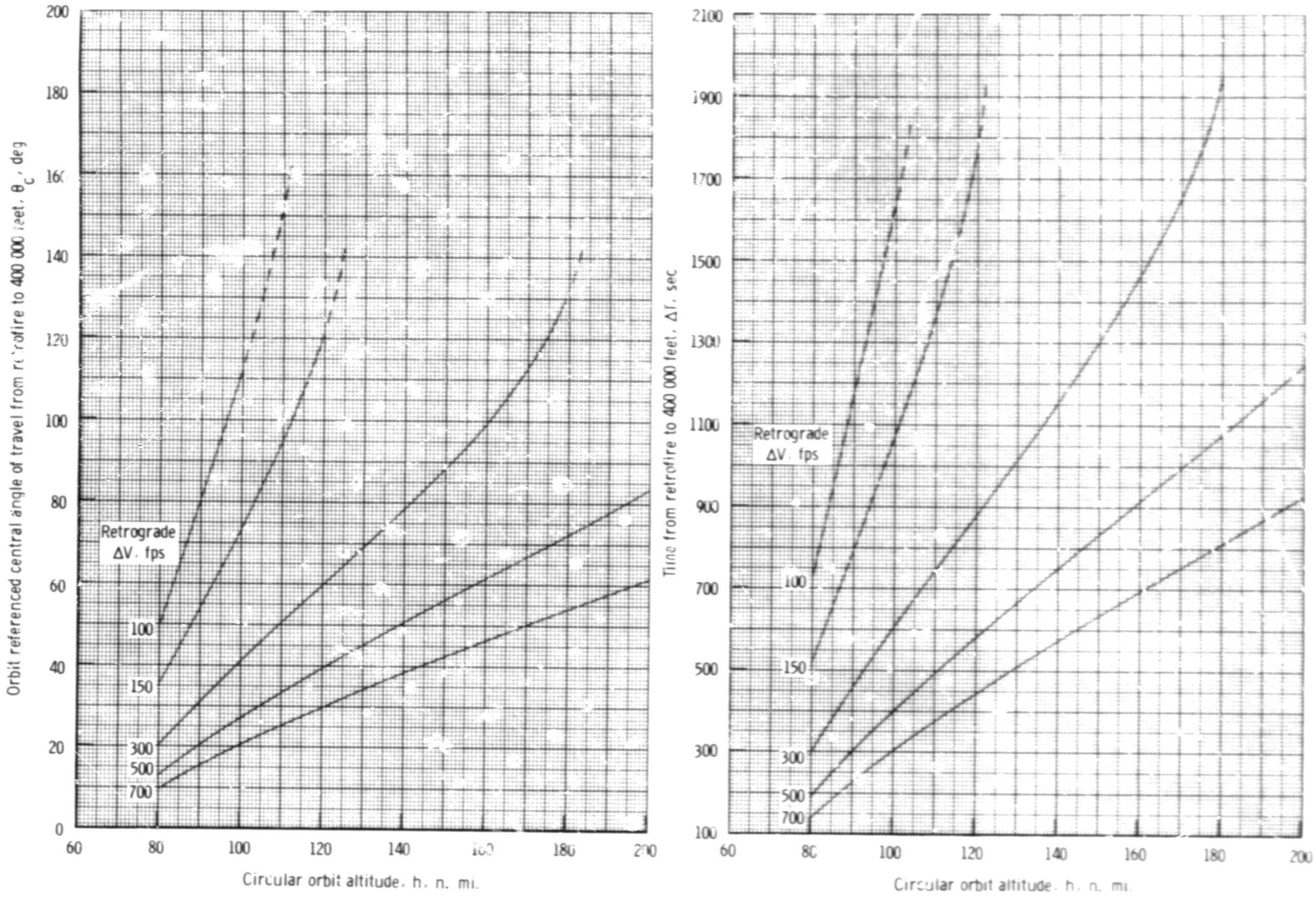
(d) Retrograde pitch angle $\beta = 30°$

Figure 1. - Continued.



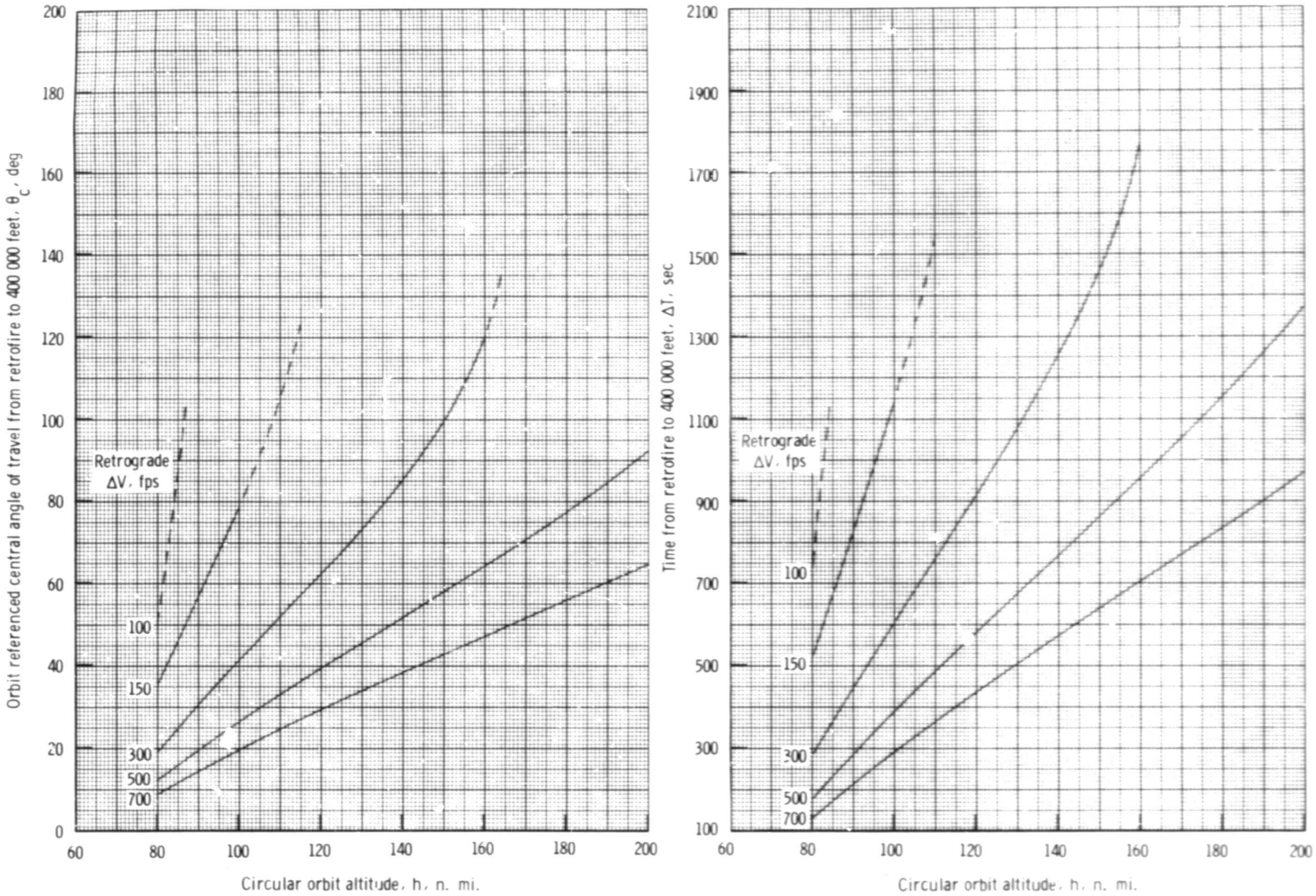
(e) Retrograde pitch angle $\beta = 40°$

Figure 1. - Continued.



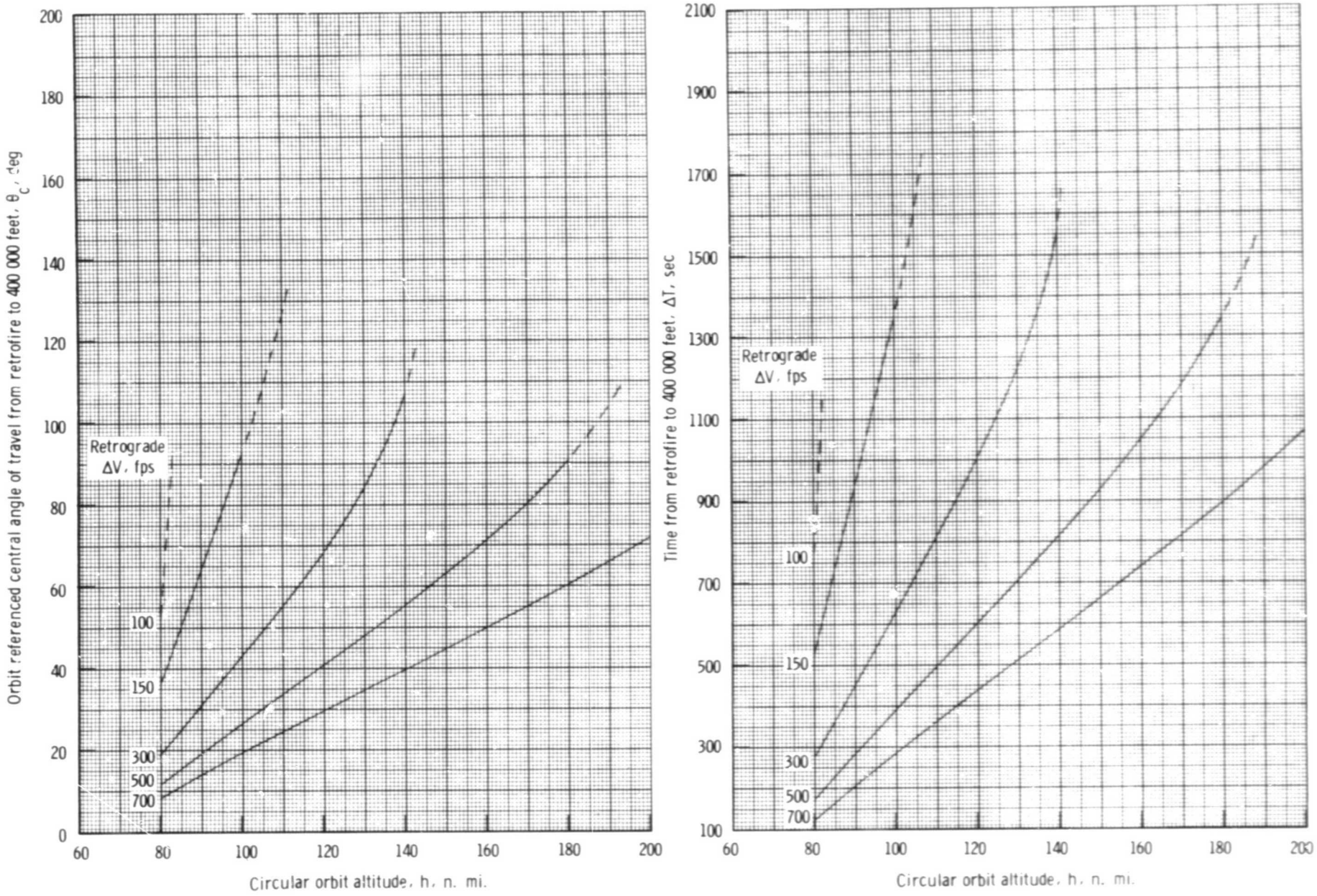
(f) Retrograde pitch angle $\beta = 50°$

Figure 1. - Continued.



(g) Retrograde pitch angle $\beta = 60°$

Figure 1. - Continued.



(h) Retrograde pitch angle $\beta = 70°$

Figure 1. - Concluded.

REFERENCES

1. Suler, Frank J.: General Parametric Reentry Study for Near Earth Orbits. MSC Internal Note 65-FM-45, April, 1965.

2. Pruett, William R.: A Parametric Study of Central Angle of Travel and Time for Reentry From Near Earth Orbits. MSC Internal Note 66-FM-79, August 12, 1966.